EEB 2245/2245W Spring 2010

Study guide for exam #4

Questions for the exam will be drawn from topics covered in lectures starting with the lecture on evolution of phenotypic traits on April 8th. The exam will consist of a combination of short answer questions and problems similar to those on exam #3. Any calculations required will be very simple. You will not need a calculator to solve them. You may be required to provide definitions of key concepts or to distinguish among them.

Remember: The exam #4 will be held in rooms 129 & 131 of the Biology/Pharmacy building, not in our usual lecture room. You will have the full two hours to complete the exam, but it will be written in such a way that you should have little difficulty finishing in an hour and fifteen minutes or less.

Evolution of quantitative traits

- Know the three consequences of polygenic inheritance.
- Know how phenotypic variance, V_P, is partitioned into genetic variance, V_G, and environmental variance, V_E.
- Know how heritability, h^2
    - Is defined
    - Is interpreted
    - Can be estimated from the relationship between parental and offspring phenotypes (be able to draw or interpret a simple graph)
- Given a phenotype mean before selection, a phenotype mean after selection, and the heritability, be able to calculate
    - The response to selection
    - The phenotype in the next generation
    - Refer to the example problem on the last page
- Be able to define phenotypic plasticity and to provide an example.

Sexual selection

- Know the relationship between natural selection and sexual selection.
- Know how sexual selection is defined.
- Be able to state the two major ways in which sexual selection occurs.
- Bateman's principle: Be able to explain what it says and to explain the reasons it holds.
- Know the difference between primary and secondary sexual characters and which set of characters sexual selection operates on.
- Be able to provide an example of a sexually selected trait in birds of paradise or Australian bower birds (refer to the YouTube videos if you need a reminder).
- Be able to describe Fisher's process of runaway sexual selection.

Evolution of altruism

- Be able to provide an evolutionary definition of altruism and to recognize it if an example is provided.
- Know the two different ways in which evolutionary biologists can explain the evolution of altruism.
- Know the requirements for altruism to evolve when it is reciprocal.
- Be able to state Hamilton's rule and to apply it if given the relatedness coefficient and the information necessary to calculate the costs and benefits of altruistic behavior.
    - Refer to the example problem on the last page

Ecotypes and adaptive variation

- Be able to define "ecotype" and to explain the kinds of experiment that are needed to distinguish ecotypes from populations that are merely different.
- Be able to identify whether natural selection or genetic drift is more important in the evolution of ecotypes.
- Be able to explain how the experiments on wild phlox (*Polemonium viscosum*) described in lecture show that among population differences in this species are adaptive and that the krumholz and summit populations represent different ecotypes.
- Be able to explain the roles that geographic isolation plays in the evolution of ecotyptes.

Species and speciation

- Be familiar with the two species concepts we discussed. Be able to recognize each, to distinguish between them, and to apply scenarios to decide whether individuals are part of the same or different species.
- Be able to explain why reproductive isolation plays such a key role in the biological species concept.
- Be able to list, recognize, and define (or give an example of) each of the reproductive isolating mechanisms we discussed.
- Be able to recognize and briefly describe each of the modes of speciation we discussed.
    - Why does geographical isolation play such an important role in allopatric speciation?
    - What roles do genetic drift and natural selection play in classical allopatric speciation?
    - Why is it useful to distinguish peripatric (founder effect) speciation from allopatric speciation? In what ways are the processes different?
    - Be able to recognize a Dobzhansky-Muller isolation mechanism. You don't need to remember the names or be able to draw the diagram, but you do need to be able to explain how they can arise.
    - Are all differences between species adaptive, i.e., did they arise as a result of natural selection? Be able to explain why or why not and to provide an example in support of your answer.

- Why does genetic drift play an important role in chromosomal speciation?

Practice problems

1. An evolutionary geneticist studying leaf shape in the genus *Pelargonium* (the genus to which garden geraniums belong) performs a set of crosses between individuals of *Pelargonium triste* and grows the offspring in a common garden. She has developed an index of the degree to which leaves are dissected vs. entire. When she plots the mid-parent value of the leaf dissection index on the x-axis and the offspring value on the y-axis and fits a regression line to the points, she finds that the slope of the regression line is 0.43.

    a. What is the heritability of the leaf dissection index in this species?

    b. What fraction of the variation in leaf dissection in this species is a result of underlying genetic differences rather than differences in the environment?

    c. In a wild population of *Pelargonium triste* near De Hoop, South Africa, our evolutionary geneticist finds that the average value of the leaf dissection index among all individuals in the population is 4.58. When examines individuals that are reproductive, however, the average leaf dissection index is 6.83. Assume that the heritability of leaf dissection in this population is the same as in the experimental population she studied.

        i. What is the selection differential on leaf dissection index?

        ii. What will the response to selection be?

        iii. What will the leaf dissection index in the next generation be?

2. Florida scrub jays delay reproduction to help their sibling (brothers and sisters) reproduce. The relatedness coefficient for full-siblings (brothers and sisters sharing the same father and the same mother) is ½. Assume that individuals delaying reproduction leave 2 fewer offspring over their lifetime than they would have if they had not delayed reproduction and that the siblings they help leave 5 more offspring than they would have otherwise.

    a. Could this behavior be explained by Hamilton's rule?

    b. Half-siblings (brothers and sisters who have only one parent in common) have a relatedness coefficient of ¼. If the behavior involved half-siblings rather than full-siblings, could this behavior be explained by Hamilton's rule?